SANS1461 QRA

A Practical Application for MHI Establishments

Quantifying Risk for Better Decisions

Practical Application of SANS 1461 for MHI Compliance.

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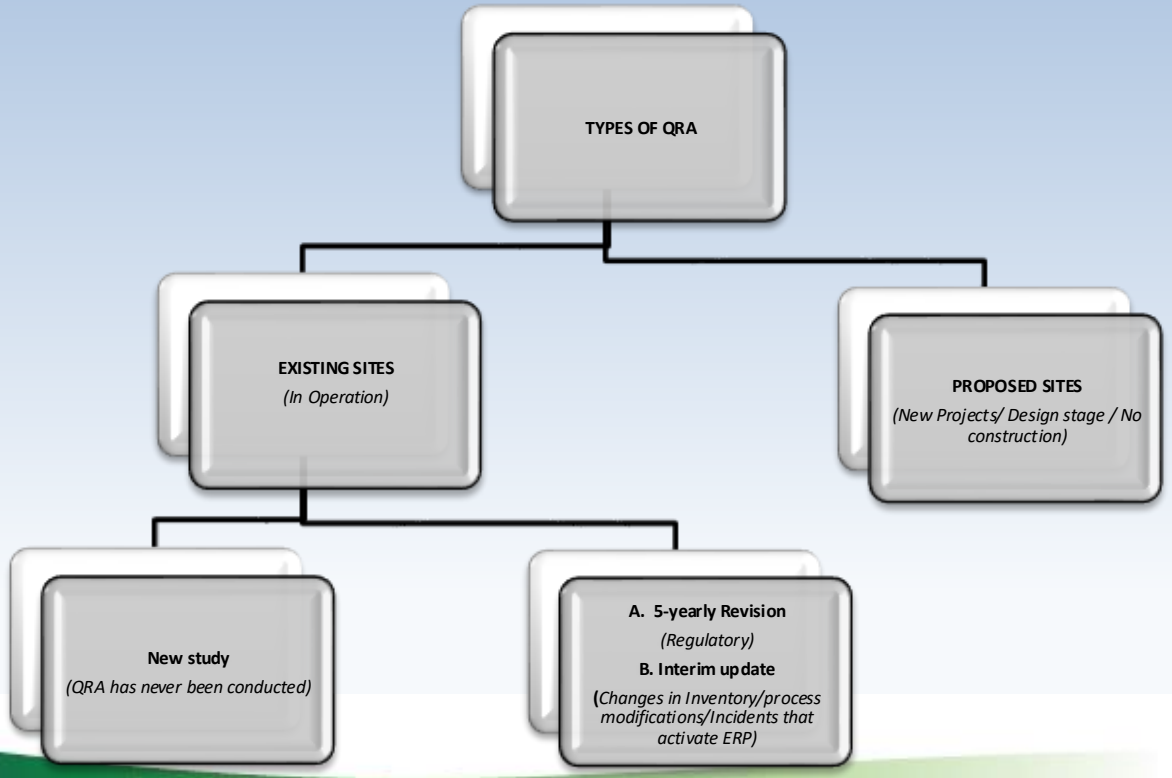
INTRODUCTION - MHI CLASSIFICATION

- MHI Regulation (2022) – Establishment with prescribed quantity of hazardous substances as listed in Chapter 1 and or 2
- MHI Classification Level – LOW MED HIGH
- Establishment has potential to cause catastrophic harm to employees and the public
- QRA (Quantitative Risk Assessment) – by an AIA
- Risk Level Results – Acceptable / Tolerable provided ALARP / Unacceptable.
- SANS 1461 – South African Standard for Major Hazard Installation Risk assessments.

COMPLIANCE CHALLENGES & FINDINGS

- **A common misconception is that a QRA is simply a modelling exercise.**
- **SANS 1461 QRA is the primary mechanism used to demonstrate compliance with the MHI Regulations and provide the technical basis for the Safety Report**

QUANTITATIVE RISK ASSESSMENT



COMPLIANCE CHALLENGES & FINDINGS

- Poor understanding of SANS 1461
- Site Data quality
- ERP & QRA
- Interpretation of MHI reports
- Using the QRA for MHI compliance [Notifications/MIPP/ PSM/Safety Reports]

SANS 1461 REQUIREMENTS FOR MHI QRA

- **Process Data collection – At least one physical site inspection to gather, and verify information relevant to the MHI QRA**
- **For new Projects a site visit is required to inspect the proposed location of the suggested installation.**

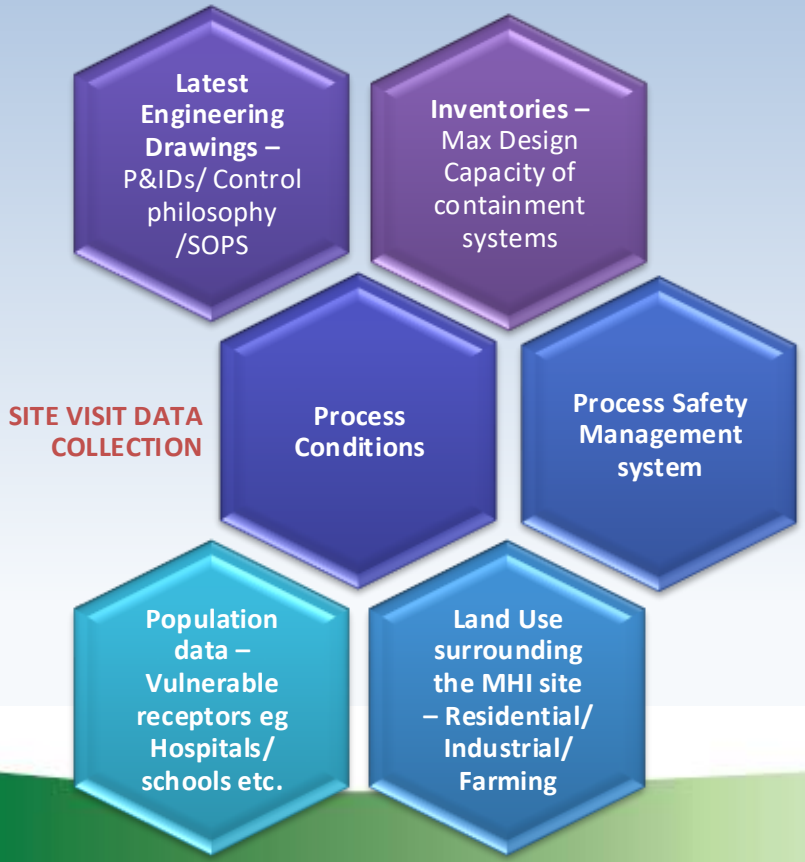
EXAMPLE - PROCESS DATA COLLECTION

- Outdated process drawings (P&IDS) / Equipment Data sheet/ Unclear processing specs etc
- Misconception on inventory – Operating Vs Maximum Design

QRA METHODOLOGY – Process Data Collection

- **Data Accuracy –** Impacts Hazard analysis results
- **Wrong Inventories** results in incorrect consequence results
- **Unavailable data –** Outdated P&IDs / no process data available etc – Incorrect risk estimation

QRA METHODOLOGY – Process Data Collection



QRA METHODOLOGY – HAZID study

SANS 1461:2024
Edition 2

Eg LPG vessels

…le 1 — Minimum failure scenarios in quantitative risk assessments for hazardous installations

1	2
Equipment type	**Scenario[a]**
Fixed storage or processing units classified as pressure vessels (for example, reactors, storage spheres) and pressurized transport units (for example, pressurized road tankers, cylinders)	1) Catastrophic rupture with instantaneous failure (including a boiling liquid expanding vapour explosion (BLEVE) where applicable). 2) Entire contents released in 10 min or large hole in the processing unit (a large hole is typically the size of the largest appurtenance on the processing unit). 3) Small hole in vessel (leak typically 10 mm diameter). 4) Pressure safety valve release (if applicable).
Fixed storage or processing units at atmospheric pressure or lower (for example, tanks, blending vessels) and atmospheric transport units (for example, standard road tankers, intermediate bulk containers (IBCs)	1) Catastrophic rupture (with bund overtopping if necessary). 2) Entire contents released in 10 min or large hole in the processing unit (a large hole is typically the size of the largest appurtenance on the processing unit). 3) Small hole in vessel (leak typically 10 mm diameter). 4) Overfilling (if applicable).
Pipe, hose, arm (onsite pipelines)	1) Pipeline, hose, arm full bore rupture. 2) Small hole in pipeline, hose, arm (typically a leak with effective diameter of 10 % to 50 % of the pipeline diameter).
Pipe (cross country pipelines) (refer also to clause 7 of this standard)	1) Pipeline full bore rupture. 2) Small hole in pipeline (leak as in accordance with clause 5).

[a] If the scenarios given in this table are not in the risk assessment, justification for their exclusion should be provided in the assessment report.

Eg Fuel Tanks

HAZARDOUS EVENTS – WHAT CAN GO WRONG ?????

Loss of containment:

- Vessel Rupture
- Large hole on the vessel – Leak
- Small hole leak
- Overfilling + Overflow
- The pipe can rupture / Leak

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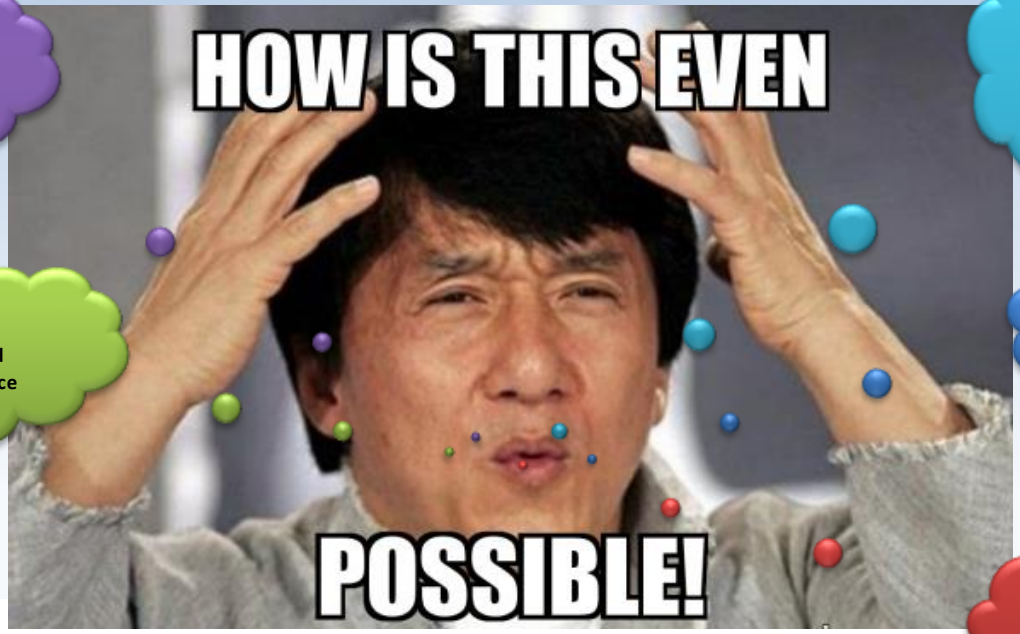
QRA METHODOLOGY – HAZID study



Our design Engineers are very competent

It has never happened before and can never happen. I have been working on this plant since 1905!!!!

We have scheduled Maintenance

Our Equipment is state of the art from Europe !!!!!

We have alarms with auto shutoff systems !!!

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QRA METHODOLOGY – HAZAN study

- **HAZARD ANALYSIS STUDY (HAZAN)**
- **Once credible failure scenarios have been identified through HAZID, these scenarios must be analysed to understand how they develop into major incidents and what barriers THE SITE HAS to prevent escalation.**
- **For each failure scenario - descriptions of the failure modes, postulated causes, preventative measures in place, expected consequences of the hazardous events and protective or mitigative measures in place**

QRA METHODOLOGY – HAZAN study

SITE VISIT data collected

SITE VISIT data collected

EQUIPMENT SECTION	CAUSES	PREVENTATIVE MEASURES IN PLACE	LOSS OF CONTAINMENT EVENT	OVERALL CONSEQUENCES	MITIGATION MEASURES
BULK TANKS	- Instrument failure eg incorrect reading. - Human/operator error. - Wrong pipe lineup.	- Automatic Gauging system (ATG) which monitors level from the control room. - ATG with High level alarm - HHLA SIL 2 Rated - Veryfy ATG with manual dipping and stock recon. - Indipendent LT on tanks which is interlocked to a pnematic auto shut off valve. - Annual testing and calibration. - SOProcedure specifies hourly patrol of line while receiving. -	**Overfill, Overflow of highly flammable liquid**	- Large spill that spreads over the ground. - Pool fire over surface of spill - Possible delayed explosion from flammable vapours but more likely flash fire. - Onsite and offsite injuries and possible fatalities. Employees and possibly public persons exposed to high pool radiation levels or engulfed in flammable vapour cloud. - Environment – spills may sip into the ground and thereby affecting the environment. - Financial impact to the organisation.	- Bulk tanks are housed in suitably designed bunded area. - Hazardous area classification done and electrical equipment is intrinsically safe as per specified zoning. - All tanks are earthed from static electicity. - Foam spray in bunds - Water tank - ERP

- **Method - Bow tie analysis example (Flammable liquid)**
- **Different containment systems – Storage vessels, RT, Pipes, Hoses, etc**

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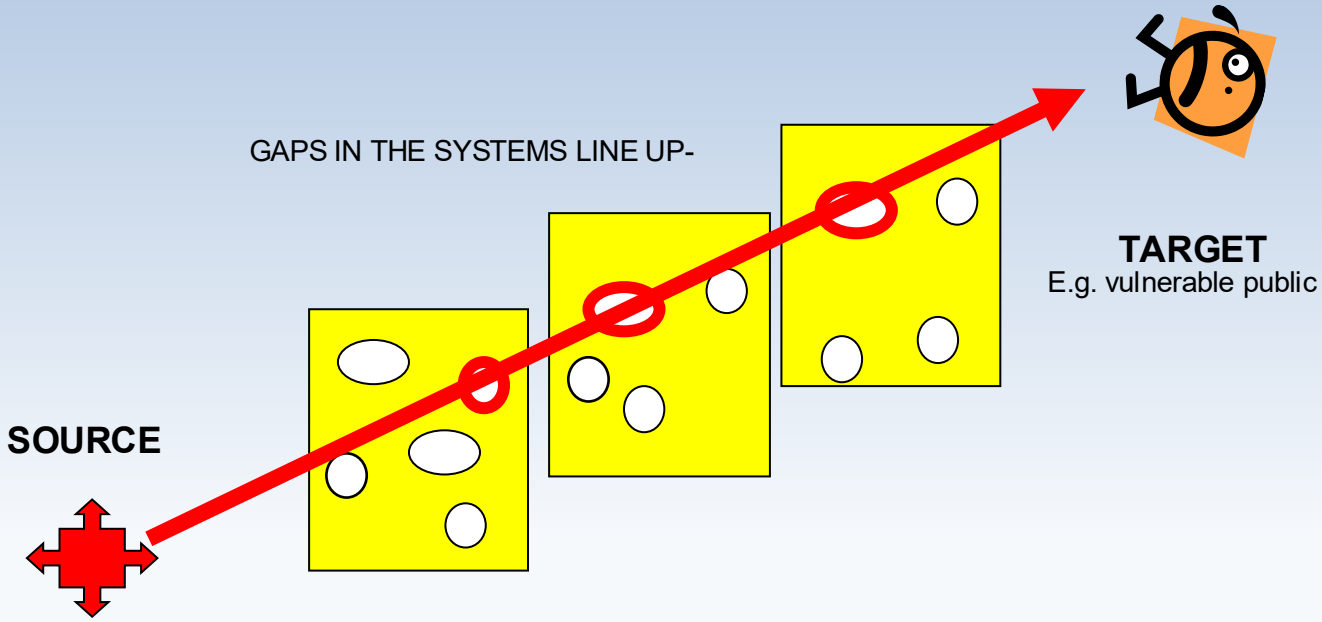
LAYER OF PROTECTION MANAGEMENT



E.g. LPG, Chlorine, Ammonia – Bulk storage,

CONSEQUENCE ANALYSIS

- **Magnitude of Consequence depends on the response time to isolate**
- **Response time depends on isolation systems in place on the site**
- **Isolation systems limit the amount of hazardous material released during loss of containment. Case by case situation and depends on the complexity of the site**
- **Layers of protection considered during QRA**
  - Automated Blocking systems – ASOV, EFV,
  - Semi Automated blocking systems – ROSOV
  - Non Automated blocking systems – Manual valves
  - Sources of ignition
  - Fire suppression and restriction systems
  - Intervention by operators – Estop
  - Breakaway couplings
  - Non Return Valves
  - Bunding

CONSEQUENCE ANALYSIS

Response time for isolation depends on the blocking systems on the plant

Automatic Response	Non Automated Response	No response
• ASOV – 60s release • ROSOV – 5 min release	• Detection + alarm+ Manual isolation – 20min release • Visual observation + Manual isolation	• Maximum release of containment system e.g. at night/ shut down periods > 60min release

WHICH LAYERS OF PROTECTION DO YOU HAVE ON SITE TO BLOCK LOSS OF CONTAINMENT

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FREQUENCY ANALYSIS

- Failure frequencies are published by various reliability institutions, but the best failure data to use is plant-specific, if available and if treated in a sound statistical manner.
- Reliability of Layers of protection – Probability of failure of ASOV/ ROSOV systems

QRA RESULTS

- **Individual Risk** (Risk of death/ per person/ year)
- **RISK = CONSEQUENCE x FREQUENCY**
- **Risk Judgement** - The hazardous installation risk assessment shall indicate in a clear statement whether the risks or aspects of the risks are **intolerably high**, **tolerable provided as low as reasonably practicable (ALARP)**, or **broadly acceptable** in terms of location specific individual risk for employees and members of the public, as well as for societal risk

QRA RESULTS

EMPLOYEE RISK

- **Risk Judgement** – Public Risk , Employee risk

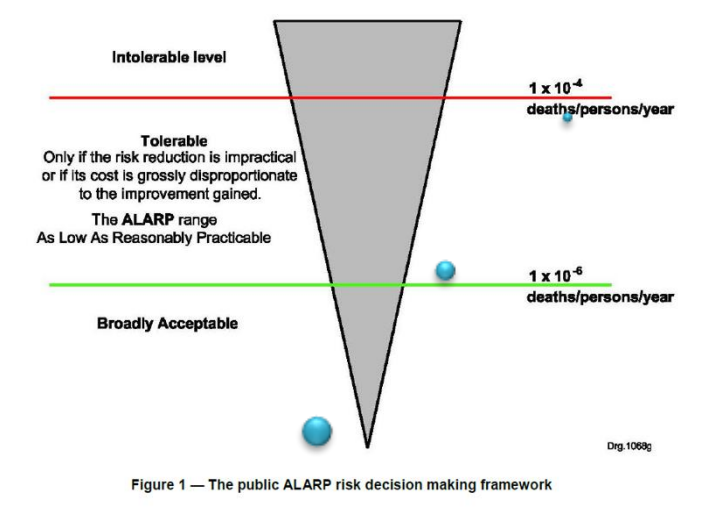

Figure 1 — The public ALARP risk decision making framework

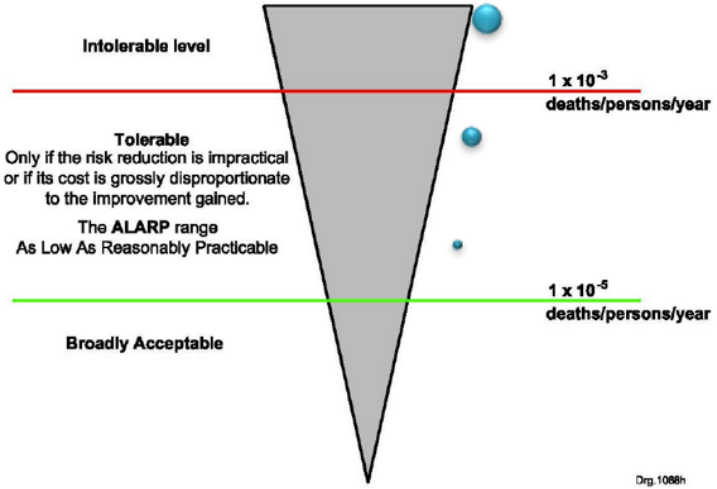

Figure 2 — The employee ALARP risk decision making framework

PUBLIC RISK

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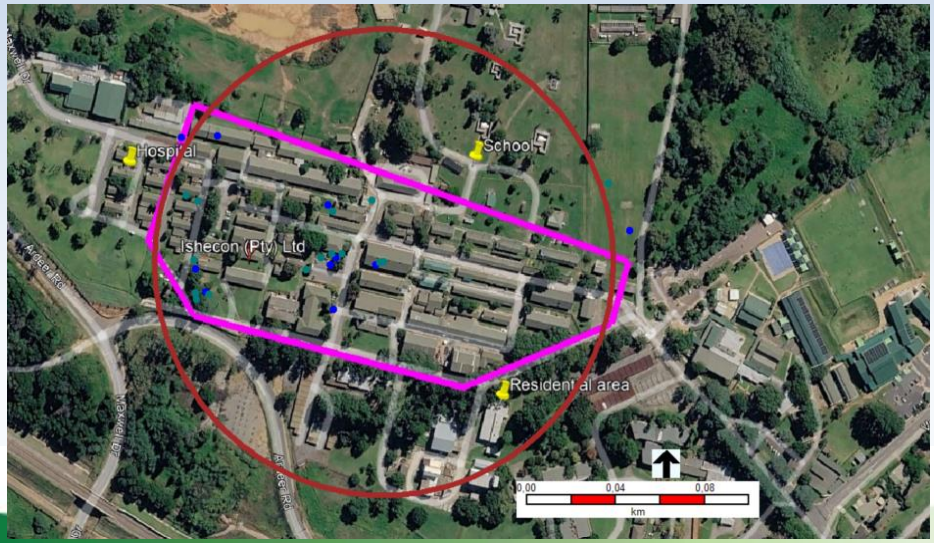
CASE STUDY – CONSEQUENCE RESULTS

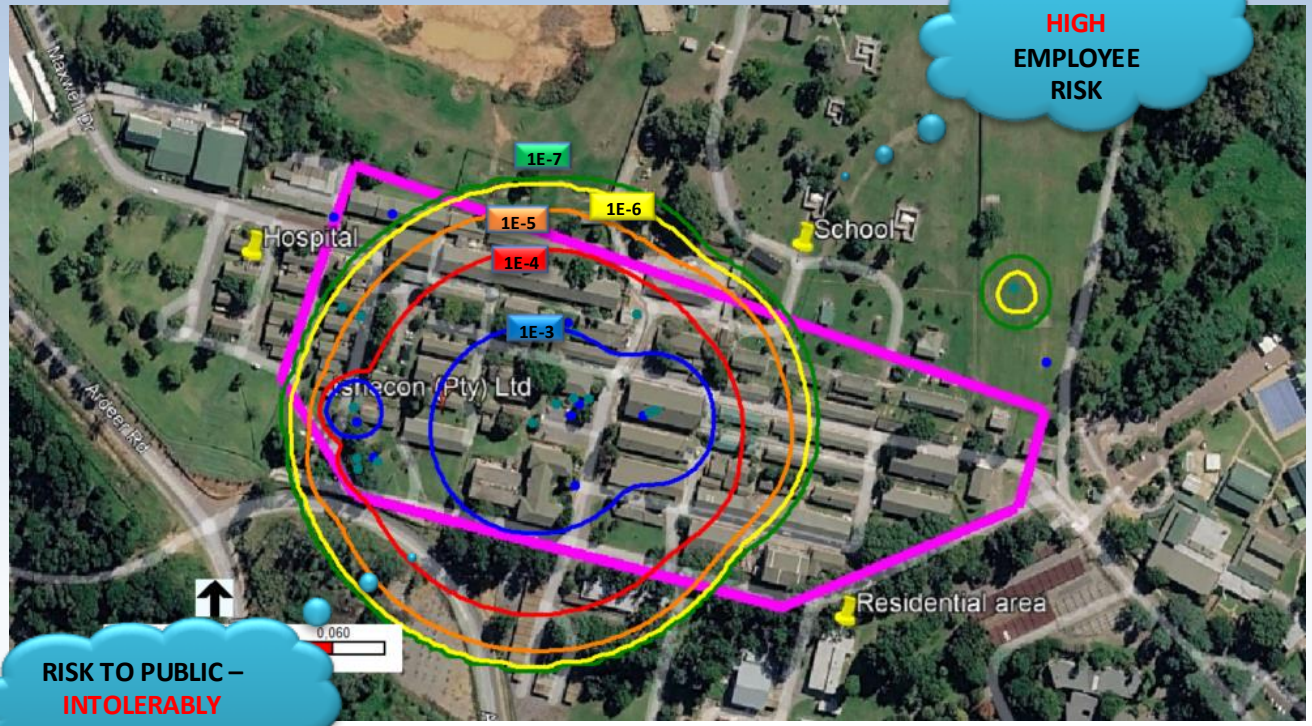
Worst case explosion going over residential area, school

CASE STUDY – CONSEQUENCE RESULTS

- Consequence impact indicates distances in which the Thermal radiation/ Explosion overpressure / Toxic dispersion.
- This will assist in offsite Emergency planning/ public protection/ Facility citing and land-use planning



CASE STUDY – RISK JUDGEMENT



INTOLERABLY HIGH EMPLOYEE RISK

RISK TO PUBLIC – INTOLERABLY HIGH

MHI QRA & REGULATORY COMPLIANCE

MHI Regulation 4 (NOTIFICATIONS)

- Form A requirements eg Maximum inventories , Neighbours and possible domino effects, Affected communities , ERP compliance with SANS1514
- ETC

MHI Regulation 10 (QRA)

- A duty holder must, after consultation with the relevant health and safety representative or health and safety committee, ensure that **an approved inspection authority carries out a risk assessment in accordance with SANS 1461** at intervals not exceeding five years or when there is a change in the establishment

MHI Regulation 11 (MIPP)

- The **MIPP must provide for a high level of protection for employees and the public** and must include at least–
- (d) commitments towards the maintenance and continual improvement of the policy;

MHI Regulation 12 (SAFETY REPORT)

- The safety report must demonstrate a suitable and sufficiently documented plan
- to **ensure–**
- **(a) that reliable built-in safety has been incorporated into the–**
- **(i) design;**
- **(ii) construction;**
- **(iii) operation; and**
- (iv) maintenance of any equipment and infrastructure used in the
- establishment

MHI QRA & REGULATORY COMPLIANCE

- **Compliance with the Regulations requires a good QRA, A good QRA provides the evidence needed for regulatory compliance**

- **Credible SAN1461 Quantitative Risk Assessment provides evidence for**
  - **Hazard identification**
  - **Risk evaluation**
  - **Adequacy of safe guards**
  - **Emergency preparedness**
  - **Gap analysis and continuous improvement**

MHI QRA & REGULATORY COMPLIANCE

EXAMPLE: SANS1461 QRA Output	MHI REGS COMPLIANCE APPLICATION
Worst case & more likely Hazard Scenarios	**Safety Report –***identification of major hazards*
Consequence Modelling- max impact distance to public	**Onsite and Offsite Emergency planning**
Individual Risk Results	**Risk acceptability,** *Risk reduction and ALARP Demonstration*
Societal Risk	**Public Protection**
Risk Contours	**Land use planning**
HAZAN Study - Layers of protection (Barrier assessment)	**PSM Gap analysis -** *identify areas of improvement for mitigation and prevention*

CONCLUSION – KEY TAKEAWAYS

- **A SANS 1461 QRA is not merely a risk study.**
- **It is the tool used to demonstrate compliance with the MHI Regulations through:**
  - ✅ **Hazard identification**
  - ✅ **Risk quantification**
  - ✅ **Demonstration of ALARP**
  - ✅ **Support for Safety Reports**
  - ✅ **Emergency response planning**
  - ✅ **Protection of workers and the public**

THANK YOU